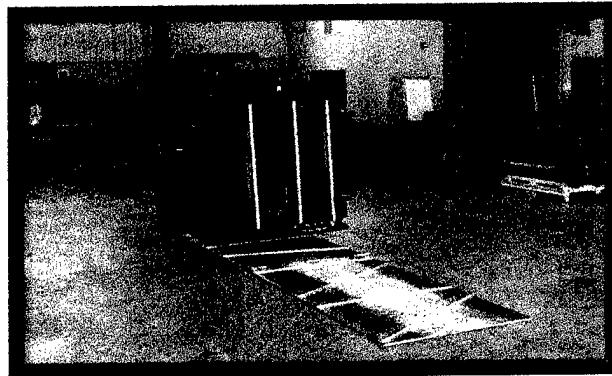


**FINAL REPORT
AUGUST 2001**

REPORT NO. 01-20



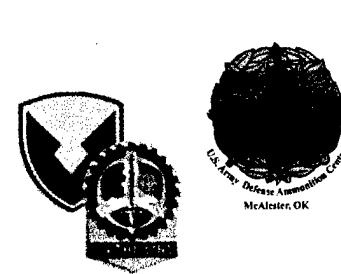
**METAL PALLET, STANDARD SIZE 44" x 40",
WITH MODIFIED PA-XXX BOTTOM ADAPTER,
MIL-STD-1660 TESTS**

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**REPORT NO. 01-20
METAL PALLET, STANDARD SIZE 44" X 40",
WITH MODIFIED PA-XXX BOTTOM ADAPTER,
MIL-STD-1660 TESTS**

AUGUST 2001

ABSTRACT

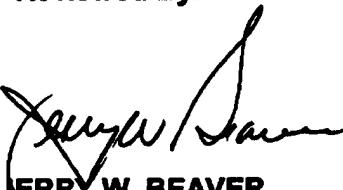
The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SMAAC-DEV), was tasked by U.S. Army Tank-automotive and Armaments Command-U.S. Army Armament Research, Development and Engineering Center (TACOM-ARDEC) to conduct testing IAW MIL-STD-1660, "Design Criteria for Ammunition Unit Loads" on the Metal Pallet, standard size 44" x 40", with modified PA-XXX bottom adapter. No significant flaws were found in the pallet units. As a result of the performance of Pallet Unit 1 and Pallet Unit 2 during testing, the Metal Pallet, standard size 44" x 40", with modified PA-XXX bottom adapter, is recommended for US Army-wide use.

Prepared By:



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Validation Engineer

Reviewed By:



JERRY W. BEAVER
Chief, Validation Engineering Division

U.S. ARMY DEFENSE AMMUNITION CENTER

VALIDATION ENGINEERING DIVISION
MCALESTER, OK 74501-9053

REPORT NO. 01-20

**METAL PALLET, STANDARD SIZE 44" x 40",
WITH MODIFIED PA-XXX BOTTOM ADAPTER,
MIL-STD-1660 TESTS**

TABLE OF CONTENTS

PART	PAGE NO.
1. INTRODUCTION	1-1
A. BACKGROUND	1-1
B. AUTHORITY	1-1
C. OBJECTIVE	1-1
D. CONCLUSION	1-1
2. ATTENDEES	2-1
3. TEST PROCEDURES	3-1
4. TEST EQUIPMENT	4-1
5. TEST RESULTS	5-1
6. DRAWINGS.....	6-1

PART 1 – INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SMAAC-DEV), was tasked by TACOM-ARDEC, to conduct testing IAW MIL-STD-1660, "Design Criteria for Ammunition Unit Loads," on the Metal Pallet, standard size 44" x 40", with modified PA-XXX bottom adapter. The unitization procedures were provided by DAC, Transportation Engineering Division (SMAAC-DET).

B. AUTHORITY. This test was conducted IAW mission responsibilities delegated by the U.S. Army Operations Support Command (OSC), Rock Island, IL. Reference is made to the following:

1. Change 6, AR 740-1, 18 August 1976, Storage and Supply Activity Operation.
2. IOC-R, 10-23, Mission and Major Functions of USADAC, 7 January 1998.

C. OBJECTIVE. The objective of the tests was to verify an engineering change proposal (ECP) to modify the bottom adapter and to properly interface with PA-XXX metal containers on the standard metal pallet. The modified pallet unit had to meet MIL-STD-1660 requirements prior to the acceptance of the pallet adapter for use by the US Army.

D. CONCLUSION. Two pallet units were evaluated using MIL-STD-1660 test requirements. No significant flaws were found in the two units during testing. As a result of the performance of the two pallets during the test, the Metal Pallet, standard size 44" x 40", with modified PA-XXX bottom adapter is recommended for US Army-wide use.

PART 2 - ATTENDEES

DATES PERFORMED: Pallet 1: 20-22 February 2001
 Pallet 2: 26-28 February 2001
 Pallet 3: Not Tested

ATTENDEE

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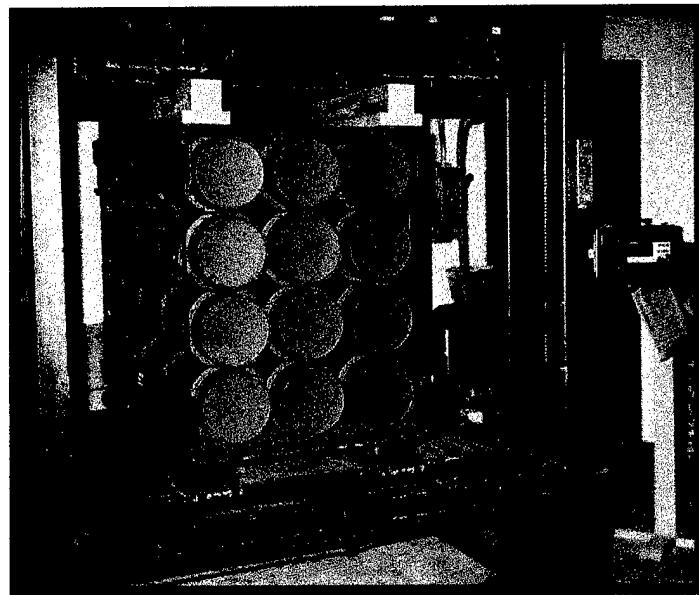
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PART 3 - TEST PROCEDURES

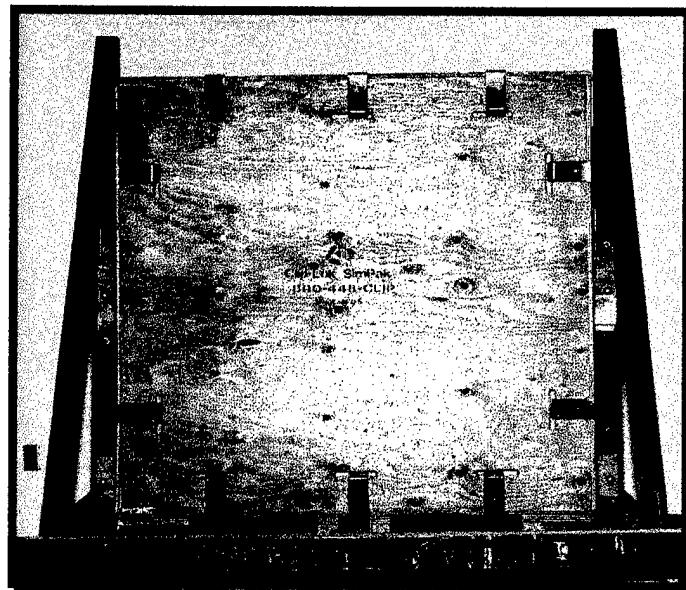
The test procedures outlined in this section were extracted from the MIL-STD-1660, "Design Criteria for Ammunition Unit Loads," 8 April 1977. This standard identifies steps that a unitized load must undergo if it is to be considered acceptable. The seven tests that were conducted on the test pallets are summarized below.

A. STACKING TEST. The unit load was tested to simulate a stack of identical unit loads stacked 16 feet high, for a period of one hour. This stacking load was simulated by subjecting the unit load to a compression weight equal to an equivalent 16-foot stacking height. Figure 1 below shows an example of a unit load in the compression tester.



**Figure 1. Example of Compression Tester.
(2.75-inch Hydra 70, PA151 Rocket Pallet in the compression tester.)**

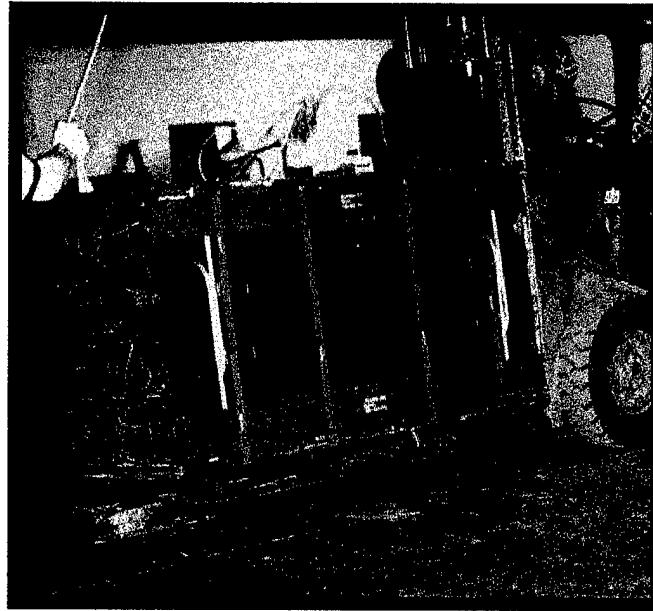
B. REPETITIVE SHOCK TEST. The repetitive shock test was conducted IAW Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen was placed on (not fastened to) the platform. With the specimen in one position, the platform was vibrated at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of approximately 3 cycles-per-second. The frequency was steadily increased until the specimen left the platform. The resonant frequency was achieved when a 1/16-inch-thick feeler gage momentarily slid freely between every point on the specimen in contact with the platform at some instant during the cycle. Midway into the testing period, the specimen was rotated 90 degrees, and the test continued for the duration. Unless failure occurred, the total time of vibration was three hours. Figure 2 shows an example of the repetitive shock test setup.



**Figure 2. Example of the Repetitive Shock Test.
("Clip-Lok" pallet on the vibration table.)**

C. EDGEWISE ROTATIONAL DROP TEST. This test was conducted using the procedures of Method 5008, Federal Standard 101. The procedure for the edgewise rotational drop test is as follows: The specimen was placed with one end of the pallet supported on a beam nominally 6 inches high. The height of the beam was increased if necessary to ensure that there was no support for the skids between the ends of the pallet when dropping took place, but was not high enough to cause the pallet unit to tip over or slide on the support beam when raised for the drops. The unsupported end of the pallet was then raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection conforms to the following tabulation:

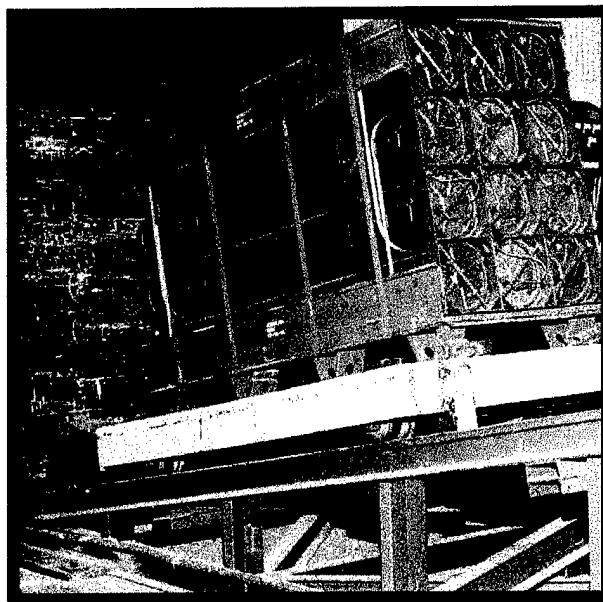
GROSS WEIGHT (WITHIN RANGE LIMITS) (Pounds)	DIMENSIONS OF ANY EDGE, HEIGHT OR WIDTH (WITHIN RANGE LIMITS) (Inches)	HEIGHT OF DROPS ON EDGES	
		Level A (Inches)	Level B (Inches)
150-250	60-66	36	27
250-400	66-72	32	24
400-600	72-80	28	21
600-1,000	80-95	24	18
1,000-1,500	95-114	20	16
1,500-2,000	114-144	17	14
2,000-3,000	Above 145- No limited	15	12
Above – 3,000		12	9



**Figure 3. Example of Edgewise Rotational Drop Test
(2.75-inch Hydra 70, PA151 Rocket Pallet)**

D. INCLINE-IMPACT TEST. This test was conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the incline-impact test is as follows: The specimen was placed on the carriage with the surface or edge to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage was brought to a predetermined position on the incline and released. If it were desired to concentrate the impact on any particular position on the container, a nominal 4- x 4-inch timber would be attached to the bumper in the desired position before the test. The carriage struck no part of the timber. The position of the container on the carriage and the sequence in which surfaces and edges were subjected to impacts was at the option of the testing activity and depended upon the objective of the test. This test was to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen was subjected to one impact on each surface that has a dimension of less than 9.5 feet. Unless otherwise specified,

the velocity at the time of the impact was 7 feet-per-second. Figure 4 shows an example of this test.



**Figure 4. Example of the Incline-Impact Test.
(2.75-Inch, Hydra 70, PA151 Rocket Pallet on incline-impact tester.)**

E. SLING COMPATIBILITY TEST. Unit loads utilizing special design or non-standard pallets shall be lifted, swung, lowered and otherwise handled as necessary, using slings of the types normally used for handling the unit loads under consideration. Slings shall be easily attached and removed. Danger of slippage or disengagement when load is suspended shall be cause for rejection of the unit load.

F. FORKLIFTING TESTS. The load shall be lifted clear of the ground by a forklift from the end of the load and transported on the forks in the level or back-tilt position across a hard pavement for a distance of not less than 100 feet. The forklift shall pass over the forklift hazard course as outlined in MIL-STD-1660. The forklift shall pass over the forklift hazard course 3 times in approximately 23 seconds per pass, and then be brought to a stop. The

load shall be observed for deflection and damage. The load shall be rotated 90 degrees and the load lifted from the side and the above steps repeated.

G. DISASSEMBLY TEST. Following all rough handling tests the unit load may be squared up within 2 inches of its original shape on a flat level surface. The strapping shall then be cut and removed from the palletized load. Assembly of the load shall be such that it retains its unity upon removal of the strapping.

PART 4 - TEST EQUIPMENT

A. COMPRESSION TESTER.

- | | |
|-----------------------|----------------------|
| 1. Manufacturer: | Ormond Manufacturing |
| 2. Platform: | 60- x 60-inches |
| 3. Compression Limit: | 50,000 pounds |
| 4. Tension Limit: | 50,000 pounds |

B. TRANSPORTATION SIMULATOR.

- | | |
|------------------|---------------------|
| 1. Manufacturer: | Gaynes Laboratory |
| 2. Capacity: | 6,000-pound payload |
| 3. Displacement: | 1/2-inch amplitude |
| 4. Speed: | 50 to 400 RPM |
| 5. Platform: | 5- x 8-foot |

C. INCLINED PLANE.

- | | |
|------------------|--------------------|
| 1. Manufacturer: | Conbur Incline |
| 2. Type: | Impact Tester |
| 3. Grade: | 10 percent incline |
| 4. Length: | 12-foot |

PART 5 - TEST RESULTS

A. PALLET UNIT DATA. Three pallet units were inertly loaded to the specified design weight using sand to bring each container individually to the required weight. Special care was taken to ensure that each container had the proper amount of weight in order to achieve a realistic pallet unit center of gravity (CG). Once properly prepared, the units were tested IAW MIL-STD-1660, "Design Criteria for Ammunition Unit Loads," requirements.

PALLET UNIT 1:

Date: 22-23 May 2001
Weight: 2,400 pounds
Length: 44-1/2 inches
Width: 40-1/8 inches
Height: 51-3/4 inches

PALLET UNIT 2:

Date: 23-24 May 2001
Weight: 2,400 pounds
Length: 44-1/2 inches
Width: 40-1/8 inches
Height: 51-3/4 inches

PALLET UNIT 3:

Date: Not Tested
Weight: 2,400 pounds
Length: 44-1/2 inches
Width: 40-1/8 inches
Height: 51-3/4 inches

B. PALLET 1 - TEST RESULTS:

- 1. COMPRESSION TEST.** Test Pallet Unit 1 was compressed with a load force of 7,300 pounds for 60 minutes on 22 May 2001. No damage was noted as a result of this test.
- 2. REPETITIVE SHOCK TEST.** Test Pallet Unit 1 was vibrated 90 minutes at 165 rpm in the longitudinal orientation and 90 minutes at 165 rpm in the lateral orientation. There was no damage to the unit as a result of this test.
- 3. EDGEWISE ROTATIONAL DROP TEST.** Test Pallet Unit 1 was edgewise rotationally dropped from a height of 15 inches on the longitudinal sides and 15 inches on the lateral sides. The strut skid welds broke on the drop end of the middle skid. The damage was deemed to be minor with further inspection to be done during disassembly of the pallet.
- 4. INCLINE-IMPACT TEST.** Test Pallet Unit 1 was incline-impacted on all four sides with the unit impacting the stationary wall from a distance of 8 feet. Again, no additional problems were encountered.
- 5. SLING COMPATIBILITY TEST.** Test Pallet Unit 1 was lifted off of the ground using the top lift adapter by four points, three points, two diagonal points, and two adjacent points. No shifting of the containers or permanent deformation of the top lift adapter was noted.
- 6. FORKLIFTING TEST.** Test Pallet Unit 1 was lifted from the end of the pallet on the forks of the forklift truck and carried over the hazard course three times with no damage or instability noted. The unit was lifted from the side of the pallet and the above steps accomplished with no problems encountered.

7. DISASSEMBLY TEST. During the disassembly of the unit the only additional damage found on the pallet was that a deck weld strut in the middle skid had a minor crack. The pallet could have continued to be used in a safe manner, therefore the unit passed.

8. CONCLUSION. Test Pallet Unit 1 met MIL-STD-1660, "Design Criteria for Ammunition Unit Loads".

C. PALLET 2 - TEST RESULTS:

1. COMPRESSION TEST. Test Pallet Unit 2 was compressed with a load force of 7,300 pounds for 60 minutes on 23 May 2001. No damage was noted as a result of this test. See Figure 5 for test setup.



Figure 5. Test setup of Compression Test.

2. REPETITIVE SHOCK TEST. Test Pallet Unit 2 was vibrated 90 minutes at 165 rpm in the longitudinal orientation and 90 minutes at 165 rpm in the lateral orientation. There was no damage to the unit as a result of this test. See Figure 6 for test setup.

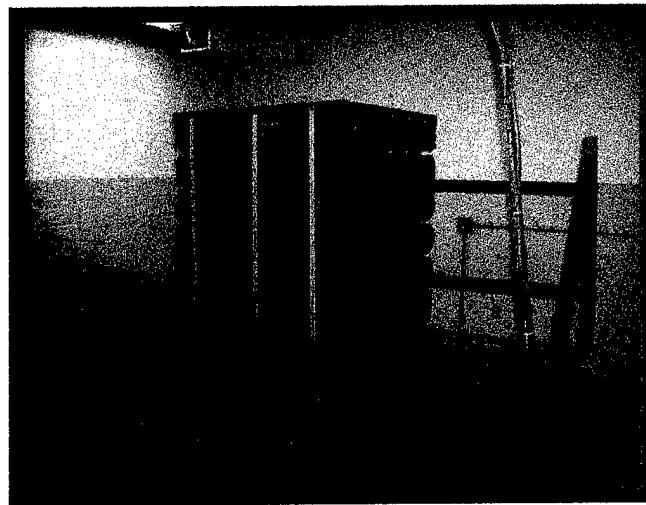


Figure 6. Test setup of Repetitive Shock Test.

3. EDGEWISE ROTATIONAL DROP TEST. Test Pallet Unit 2 was edgewise rotationally dropped from a height of 15 inches on the longitudinal sides and 15 inches on the lateral sides. The post skid welds broke on the drop end in the middle skid. The damage was deemed to be minor with further inspection to be done during disassembly of the unit. See Figure 7 for test setup.

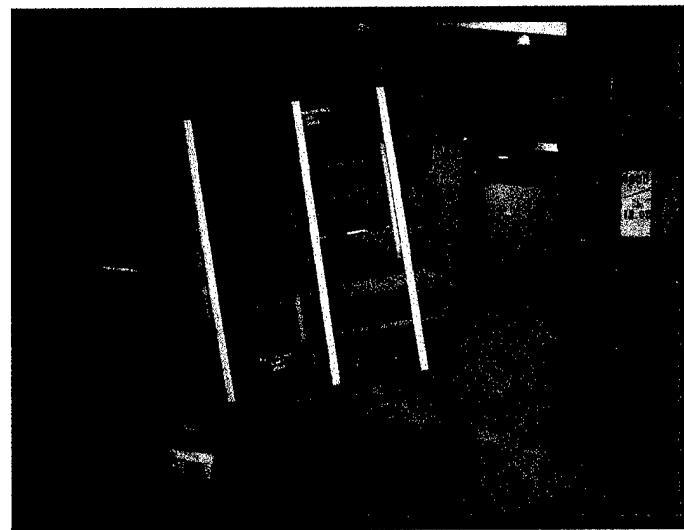


Figure 7. Test setup of Edgewise Rotational Drop Test.

4. INCLINE-IMPACT TEST. Test Pallet Unit 2 was incline-impacted on all four sides with the unit impacting the stationary wall from a distance of 8 feet. Again, no additional problems were encountered. See Figure 8 for test setup.



Figure 8. Test setup of Incline-Impact Test.

5. SLING COMPATIBILITY TEST. Test Pallet Unit 2 was lifted off of the ground using the top lift adapter by four points, three points, two diagonal points, and two adjacent points. No shifting of the containers or permanent deformation of the top lift adapter was noted.

6. FORKLIFTING TEST. Test Pallet Unit 2 was lifted from the end of the pallet on the forks of the forklift truck and carried over the hazard course three times with no damage or instability noted. The pallet lifted from the side of the pallet and the above steps accomplished with no problems encountered.

7. DISASSEMBLY TEST. During the disassembly of the unit no additional damage was found on the pallet. The post skid weld break mentioned earlier was considered to be minor. The pallet could have continued to be used in a safe manner, therefore the unit passed.

8. CONCLUSION. Test Pallet Unit 2 met MIL-STD-1660, "Design Criteria for Ammunition Unit Loads" requirements. Having met MIL-STD-1660 requirements wherein only two of three pallets must pass test criteria, the third pallet was not tested.

PART 6– DRAWINGS

The following drawing represents the load configuration that was subjected to the test criteria. The final load drawing is AMC Drawing # 19-48-4231/48-20PM1006. This drawing may be located at:

<http://www.dac.army.mil/DET/dapam/toc.html>

APPENDIX 48

UNITIZATION PROCEDURES FOR AMMUNITION AND COMPONENTS PACKED IN CYLINDRICAL METAL OR PLASTIC CONTAINERS ON 4-WAY ENTRY METAL PALLETS

CARTRIDGE, 120MM, PACKED 1 PER PA116
CYLINDRICAL METAL CONTAINER, UNITIZED
30 PER 44" X 40" PALLET; APPROX
CONTAINER SIZE 44-1/2" L X 7-3/4" W
X 7-3/4" H

NOTICE: THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN CONJUNCTION WITH
THE BASIC UNITIZATION PROCEDURES DRAWING 19-48-4231-20PM1006.

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		ENGINEER	SANDRA M. SCHULTZ
		SUPPLY ENGINEERING DIVISION	TRANSPORTATION ENGINEERING DIVISION
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		LOGISTICS ENGINEERING DIVISION	<i>J. J. Baerich</i>
DECEMBER 1988			
CLASS	093300H	DRAWING	FILE
REVISION NO. 1	JUNE 1986	19	48
SEE THE REVISION LISTING ON PAGE 2			

DO NOT SCALE

PROJECT CA 243-48-87

PALLET UNIT DATA					
ITEMS INCLUDED		HAZARD CLASS AND DIVISION		APPROX WEIGHT LBS	
NSN	DDMC	DD CLASS	COMP GROUP		
1315- 01-269-2266 01-226-7415 01-232-4638 01-333-0534 01-361-5023	C580 C786 C787 C791 C792	(08)1-2 (08)1-2 (08)1-2 (08)1-2 (08)1-2	C C E E C	2,280 2,150 2,460 2,480 2,264	

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REVISION

- REVISION NO. 1, DATED JUNE 1996, CONSISTS OF:
1. ADDING NMN NUMBERS TO "PALLET UNIT DATA" CHART.
 2. REVISING PALLET ASSEMBLY/TOP LIFT ASSEMBLY AND ALL DATA ON PAGE 5.
 3. UPDATING DRAWING TO CURRENT FORMAT.
 4. DELETING GENERAL NOTES RELATING TO STRAP CUTTER AND RE-LETTERING OTHER GENERAL NOTES.
 5. ADDING CONTAINER DRAWING NUMBER TO GENERAL NOTES.
 6. CHANGES PER ECP 34173008 AND ECP 34078075.

PAGE 2

PROJECT CA 243/40-07

